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PREPARATORY SET (EXPECTANCY)—SOME METHODS OF MEASUREMENT

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INTRODUCTION

Although affording a possible basis for more significant future inquiry, animal studies of motivation have not to date materially increased our understanding of human motivation. This seems to be largely due to the fact that experiments in this field have been concerned almost exclusively with organically specific sources of motivation such as thirst, hunger, temperature variations, sex, electric shock, and so forth. Civilized human adults also respond (though often less obviously than do animals)¹ to these primary drives or needs, but the greater part of their daily activities, often of a most strenuous nature, occurs when these basic needs are apparently well satisfied. How can this important fact be accounted for in a way that is consistent with what is known concerning the operation of the principles governing primary motivation?

With the passing of nativistic conceptions of human nature on the one hand and rationalistic conceptions on the other, psychologists and other behavioral scientists have been hard put to give a convincing account of the springs of human action. Gradually, however, there is emerging from a variety of sources what appears to be a realistic, workable solution to the problem. Such key concepts as "attitudes" (sociology), "need for security" (social work), "tension" (psychiatry), and "anxiety" (psychoanalysis) all involve the assumption that human beings

¹ Cf. Brogden (7).

are capable of being motivated, not only by organic needs (discomforts) that are immediately present and felt, but also by the mere *anticipation of such needs*. Most men obviously do not wait until they are actually hungry, or unsheltered, or attacked by their enemies before they begin making appropriate responses. If "work" has one outstanding characteristic, it is surely that it aims (i.e., on the average tends) not only to remove organic pressures that are already present but also to lessen the prospect of re-experiencing them in the future. Human beings have a strong impulsion to put as much "distance" between themselves and the brink of real privation as possible; and it is this "need for security", not actual, immediate want, that keeps most men at their jobs and largely shapes their political, economic, and social ideologies.²

Academic psychologists have not been unaware of the forward-looking functions of the human mind, but the successful scientific investigation of a phenomenon involves more than mere recognition of its reality. Lindner (37) has recently reviewed the attempts of the early introspectionists to analyze the anticipatory processes and concludes that the work of these writers "nets us very little" (p. 225). On one point, however, these writers were in fair agreement, namely, that anticipation, or expectancy,³ is commonly accompanied by a feeling of "strain", which they sought to localize in the skeletal musculature. Lange (36),

² There is nothing mysterious or teleological about the assumption that anticipation of organic needs can function as a source of motivation. All the basic needs are types of discomfort and are in the broad sense "painful". Anticipation of a need is also "painful" and carries with it motivational potentialities which may be great or small but which are functionally similar to the need that it presages. Anticipation, or expectancy, thus serves as an immediate, current motive for adaptive behavior and provides the necessary connecting link between basic needs that are not present but will tend to recur in the future and the related activity of the present. A more extended analysis of this problem has appeared elsewhere (43).

³ Warren's *Dictionary of Psychology* (1934) defines "expectancy" as "the prospective chance of an occurrence based on experience" and differentiates it from "expectation" which it defines as "a mental attitude characterized by tension and characteristic of attention". Boring (5), Cowles and Nissen (12), Grether (21), Humphreys (28), Woodworth (59), and other recent writers have, however, used "expectancy" in the sense of the second of these definitions; in the present study the two terms will be employed interchangeably.

carrying this type of analysis a step further, reached the conclusion that, as James (31) has re-phrased it, "ideational preparation itself is a consequence of muscular adjustment, so that the latter may be called the essence of the attentive process throughout" (p. 444). If, as this view held, anticipation of an impending event were not only accompanied by, but actually dependent upon, characteristic changes in the subject's motor apparatus, all that would be needed to make this phenomenon objectively identifiable and measurable (and thus lay the foundation for its scientific study) would be the development of refined methods of detecting minute muscular changes. Within the past two decades such technical progress has been made in this connection that virtually any type of muscular activity, however subtle, can be detected and recorded. But application of these improved methods has not confirmed the assumption of a necessary connection between anticipation and muscular activity. Woodworth (59) has reviewed some of the major attempts that have been made to demonstrate a muscular basis for quickness of simple reaction-time (which is known to be a function of anticipation) and shows that the results have been distinctly unsatisfactory. The negative findings of Hathaway (22), who used action-current recording, are especially noteworthy in this connection.

In extreme cases, where anticipation is so highly developed that it reaches the anxiety level and, to speak loosely, "spills over" into motor channels, it can often be detected in gross behavior. The so-called "nervous" movements of human beings are taken, as a matter of course, to indicate apprehension and "worry" on the part of the person showing them. Agitated behavior of a comparable kind has also been reported by various animal experimenters. For example, Anderson and Liddell (2) have published a record of the foreleg flexions of a sheep suffering from an "experimental neurosis", in which anticipation of a recurrent electric shock to this member was clearly revealed by anticipatory reactions of the leg before each occurrence of the shock (at intervals of one to four minutes), after which the leg remained quiet for a time. This record, described as typifying the behavior

of this and other "neurotic" sheep, is so dramatic that it is here reproduced as Fig. 1.

On the other hand, there are many instances in which expectation of an impending event is by no means so immediately evident. The lower black line in Fig. 2 shows the right foreleg flexions produced in an albino rat by an electric shock administered to this member every 20 seconds. Here, it will be noted, there are no anticipatory reactions whatever, despite the fact that

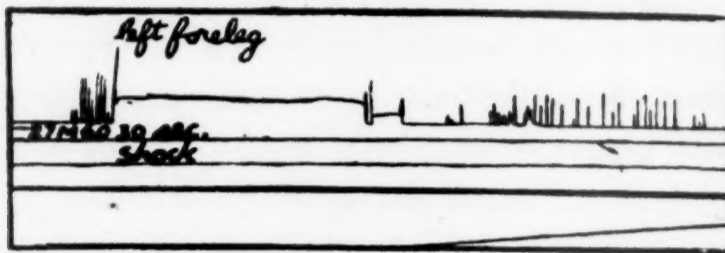


FIG. 1. The above record, reproduced from Anderson and Liddell (2), shows (top line) the left foreleg flexions of a "neurotic" sheep before and after one of a series of paired presentations of the sound of a metronome and an electric shock (at point indicated). Note the numerous anticipatory flexions prior to stimulation, which, according to these writers, always had the effect of quieting the animal, "no matter how nervous it might have been before this stimulation. The period of quiet usually lasted about a minute and then the nervous movements began again. The shock appeared to relieve the tension which had been rising since the last test" (2, p. 358).

the shock had been administered more than 50 times at the standard interval before this particular record was taken. Other rats showed essentially the same behavior under these conditions, the only outward signs of apprehension being occasional outbursts of generalized struggling.⁴ Yet, as results that will be discussed below (p. 17) plainly indicate, the absence of gross, overt reactions of an anticipatory character does not prove that these animals had no appreciation of the imminence of the successive shocks.

Variation in pulse, blood volume, respiration, metabolism, galvanic skin resistance, and other "physiological changes" have, of course, commonly been employed as indices of apprehension,

⁴ These animals were immobilized by a method similar to that described by Schlosberg (53). This investigator also reports that the only gross indication of anticipation of shock manifested by rats under the conditions of his experiment took the form of generalized struggling.

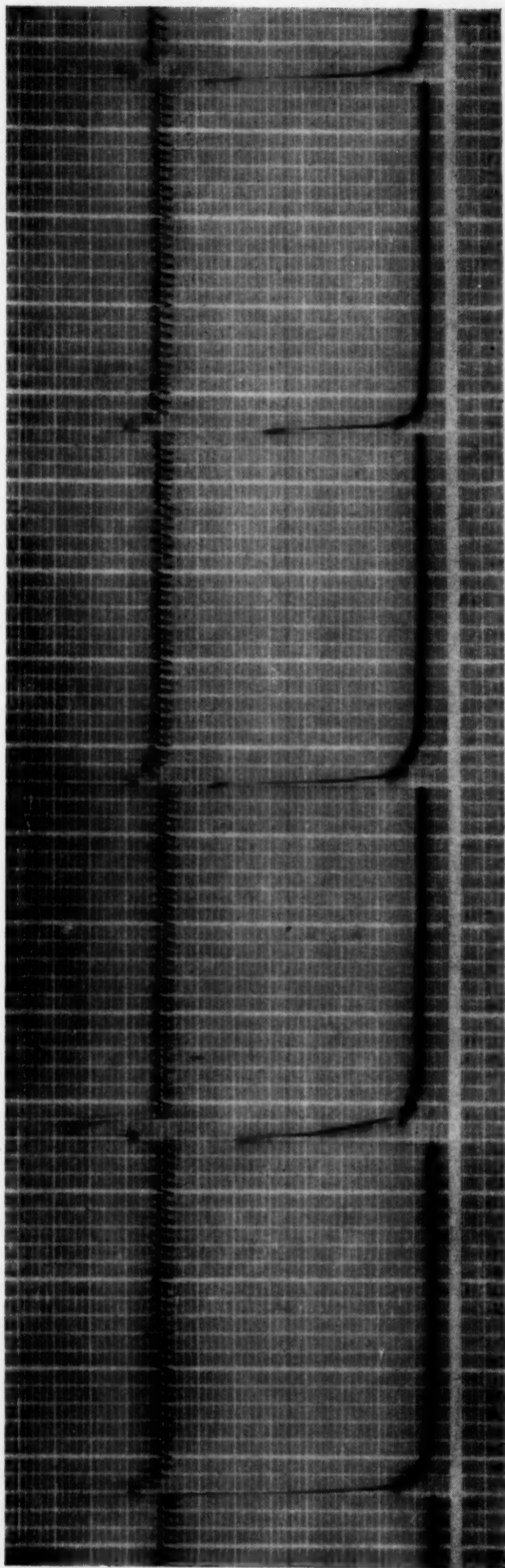


FIG. 2. The lower black line shows the right foreleg flexions produced in a rat by a momentary shock administered to this member every 20 seconds. The upper line represents the concomitant breathing behavior of the animal. Neither type of response gives any reliable indication of expectation of shock on the part of the rat (see text).

and for some purposes they have turned out to be very useful. However, much the same criticism applies to them that has just been made of tonicity changes and overt agitation as measures of this psychologically significant phenomenon, namely, that they give positive results only when anticipation becomes sufficiently intense to "overflow", in this case, into the autonomic nervous system. The upper black line in Fig. 2 represents the breathing of the rat whose leg flexions are recorded immediately below. It will be observed that this "physiological" measure gives no reliable indication of expectation of the shock prior to its occurrence.

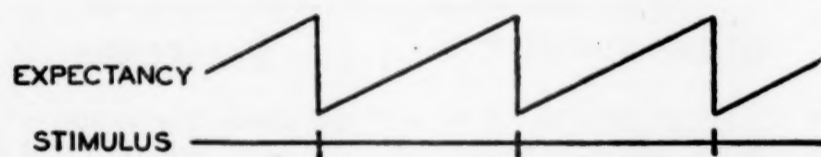


FIG. 3. This diagram, reproduced from an earlier study by the writer (43), represents the hypothetical course of expectancy between successive presentations of a psychologically significant stimulus. While admittedly schematic, the general shape of the upper line was suggested by the comments of subjects who had served in a study of the galvanic skin response to electric shock.

In an analysis of the learning process as exemplified in conditioning, which has appeared elsewhere (43), the writer has posited (on the basis of the spontaneous comments of subjects used in an investigation of the galvanic skin reaction to electric shock) that if a stimulus is presented recurrently, at regular temporal intervals, expectation of that stimulus rises and falls in the manner indicated in the schematic diagram reproduced in Fig. 3. The assumption that was made at the time of the original publication of this diagram, but not incorporated in it, was that if a stimulus does not occur at the expected point, expectancy may remain constant for a time, or perhaps even mount a little higher than usual, and will then undergo a relatively gradual decay.

As early as 1929, Schilder (52) published a somewhat similar curve, also based on introspective data, purporting to show the rise and fall of expectation (as manifested by feelings of "tension") when a flash of light occurred and was regularly

followed, five seconds later, by an electric shock. Here, again, the actual occurrence of the expected event, although painful, is represented as bringing about "relief", in the sense of lowering tension (cf. Fig. 1). Schilder's original diagram is reproduced in Fig. 4.

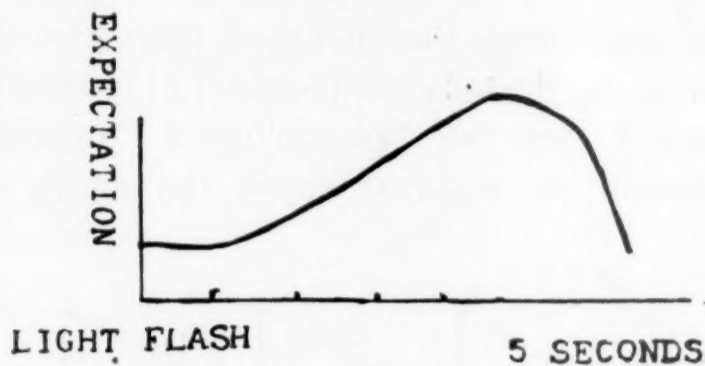


FIG. 4. Schilder (52) has presented the above curve purporting to show the rise and fall of expectancy when a light is flashed and is then followed, five seconds later, by an electric shock. The curve is based on the introspective reports of human subjects.

Apparently unfamiliar with either of the diagrams just referred to, Woodworth (59) has recently published three hypothetical curves showing possible ways in which "readiness" might be assumed to develop during a 24-second "foreperiod" between a warning signal and the stimulus to which a simple,

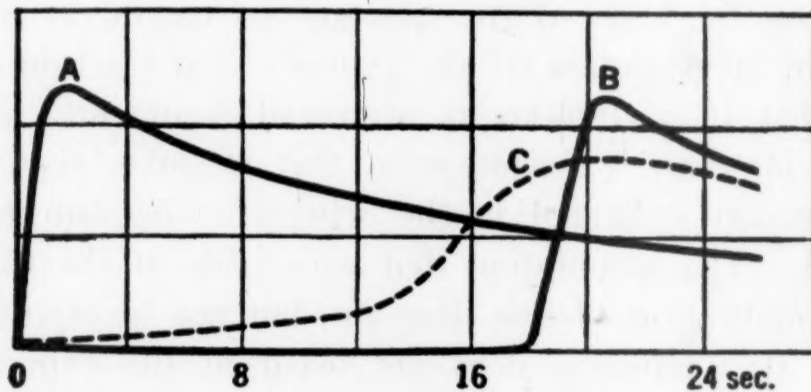


FIG. 5. "Possible curves of readiness in a long foreperiod. The fore-signal comes at 0. If curve A is correct, readiness is immediately pushed to maximum. If B is correct, readiness is pushed to a maximum at the moment when the stimulus is expected. If C is correct, there is no sharp peak of readiness in a long foreperiod" (Woodworth, 59, p. 317).

overt reaction is to be made. These curves are reproduced in Fig. 5. Curve C, it will be noted, follows somewhat the same course as the curves reproduced in Fig. 3 and Fig. 4.

The dilemma is thus apparent. The phenomenon of expectancy, or anticipation, can be detected with a considerable degree of delicacy by the method of introspection, but it cannot be precisely quantified by this method. On the other hand, the same disadvantage does not inhere in the use of overt agitation (including muscle-thickening and tremor techniques)⁵ nor in the use of the so-called physiological measures, but these methods lack sensitivity. Continued scientific progress in this field requires, therefore, the application of other methods, methods that will be objectively quantitative but that will also be sufficiently sensitive to permit effective investigation of this phenomenon at low as well as at high levels of intensity. The present study is directed to this end.

METHOD I—REACTION TIME

The difference in the latency of a simple reaction, such as releasing a key in response to a light or tone, that is observed with human subjects when the reaction stimulus is presented with and without "warning" clearly shows the rôle of expectancy, or preparatory set ("attention"), in determining the time required for such a reaction to occur. Preceded by an appropriate "ready" signal, the latency of such a reaction is greatly reduced. When Wundt (60) reported this fact many years ago, he also remarked that if a reaction stimulus occurs without being preceded by a signal, but at *regular* temporal intervals, reaction time is briefer than if the stimulus occurs at irregular intervals. This difference, he found, could be sharply accentuated "by suddenly thrusting into a long series of equidistant [homogenous] stimuli a much shorter interval which the observer [subject] does not expect. . . . The time of reaction may then easily be lengthened to one quarter of a second with strong signals [stimuli], or with weak ones to a half-second" (pp. 242-243).

The close positive relation between quickness of reaction and expectancy, or readiness, seems to offer one relatively simple yet sensitive method of objectively investigating the latter phe-

⁵ That expectancy can vary widely without concomitant changes in the skeletal musculature is clearly indicated by the results of an independent investigation (42).

nomenon. It is always an advantage whenever a phenomenon that defies direct quantification can be made a function of time. For present purposes it is assumed that the relation between expectancy and quickness of reaction is linear; but if subsequent inquiry should reveal a curvilinear relation instead, the implications of the following experiment would not be materially altered.

In order thus to obtain an *objective* record of the course of expectancy during the interval between successive presentations of a stimulus at a standard temporal interval, 100 male college students were submitted to the following procedure.⁶ They were seated in a comfortable chair in a sound-proof room and instructed to hold down a telegraph key, conveniently placed on the arm of the chair, with a gentle but continuous pressure until they heard a tone (42 d.b. above threshold, with pitch of 800 d.v.) in a pair of telephone receivers located at a distance of three feet. Upon hearing the tone the subjects were to release the telegraph key as quickly as possible and thereby terminate the tone. They were given a special incentive to do their best by being told that when the session (which lasted about 14 minutes) was over they would be informed as to how fast their reactions had been and how they compared with other subjects in this respect. Upon withdrawing from the sound-proof room, the experimenter extinguished the light (with appropriate explanation to the subject) in order to eliminate visual distraction.

Each subject first received 20 tones at an unvarying interval of 12 seconds, during the presentation of which the average latency of reaction for all subjects dropped from 369.78 milliseconds, on the 1st trial, to 231.70 ms., on the 8th trial, and then remained approximately constant for the next 12 trials. Following these 20 preliminary, or "training", trials, each subject received, without any break in continuity, 49 additional tones (making 69 in all), which also came at 12-second intervals, except on the 21st, 27th, 35th, 41st, 48th, 55th, 61st, and 68th trials. On these "test" trials, the tones came after intervals of 3, 6, 9, 12, 15, 18, 21, and 24 seconds, in balanced random order. The

⁶ The writer is indebted to Mr. N. Nelson Rayman and Mr. Eugene L. Bliss for assistance in carrying out the investigation here reported.

average reaction times of all subjects on these eight test trials were, respectively, as follows: 293.57, 254.44, 243.39, 229.02, 234.78, 239.35, 238.41, and 243.47 milliseconds. These values are represented graphically in Fig. 6. As had been anticipated (see Fig. 3 and Fig. 4), reaction time was found to be longest (expectancy lowest) when the tone came at the three-second interval. As the test interval approached the standard interval,

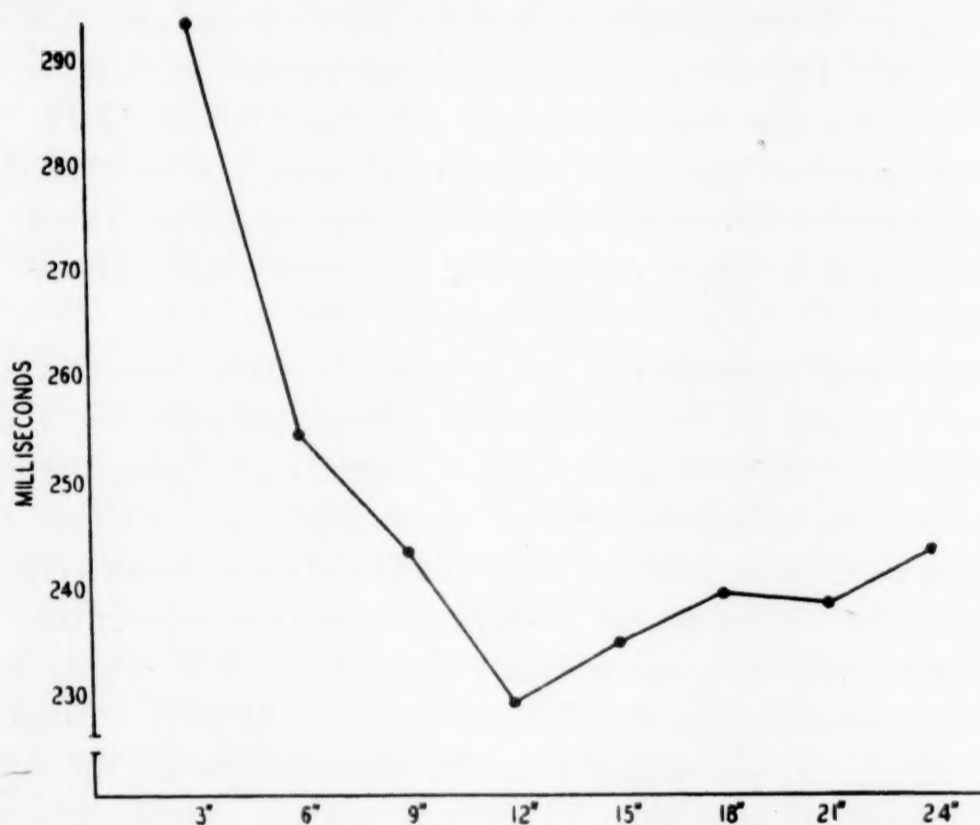


FIG. 6. This curve represents the average reaction time (in milliseconds) of 100 male college students as a function of the interval between successive presentations of the reaction stimulus (tone). The standard interstimulus interval was 12 seconds, but occasionally the stimulus occurred at one of the "test" intervals indicated along the abscissa.

the reaction time became progressively shorter (with rising expectancy) until, at the 12-second test interval—which was, of course, the same as the standard interval—the obtained reaction time was "normal", viz., 229.02 ms. as compared with the average of 231.70 ms. that was achieved by the 8th trial in the preliminary series and was maintained with relatively little variation on the standard-interval trials that were interposed (5 to 7 in succession) between the eight test trials. As the test intervals

varied beyond 12 seconds, up to 24 seconds, the average reaction time again increased but not to the same heights it had reached on the shorter test trials, which was also in keeping with the prediction.

The reliability of the difference between the average reaction time on the 3-second test trial and 12-second test trial is indicated by a critical ratio of 8.67. The critical ratio of the difference between the average reaction time on the 6-second and 12-second trials is 4.32; between the 9-second and 12-second trials is 2.50; and between the 24-second and 12-second trials, 2.31. The critical ratios of the other differences were not computed, but the consistency of the trend toward longer reaction times from the 12-second to the 24-second test trials indicates their probable reliability.

It had been assumed that many subjects would resort to counting as a means of trying to judge more accurately the time of occurrence of the successive tones. Casual questioning indicated, however, that relatively few of them made any attempt to do this and that those who did soon abandoned it as more confusing than helpful. They found, in general, that they could make what seemed to them to be the quickest reactions if they simply waited between presentations of the tone, passive but alert. Somewhat surprisingly, it was found that the presentation of the tone at test intervals shorter than 12 seconds did not significantly affect the average reaction time on the next, immediately succeeding standard 12-second trial, although the longer test intervals (18, 21, and 24 seconds) tended to have a slight effect in the direction of lengthening the next reaction. However, this effect disappeared completely by the time of the second succeeding standard-interval trial.

Some apprehension was also experienced on the grounds that the subjects might discover the approximate frequency with which the test trials were interposed between the more numerous standard-interval trials, with a resulting disturbance of the usual course of expectancy at these points. Fortunately this does not seem to have been the case. In the first place, many subjects apparently did not consciously differentiate the 9- and the 15-

second test intervals from the standard 12-second intervals. Furthermore, one test trial, namely, that involving the 12-second interval, was actually identical with the standard-interval trials, which made it additionally difficult to determine when test trials, discernable to the subject only on the basis of irregularity of interval, were to occur. The fact that subjects did not establish any periodic expectation of test (irregular) intervals is indicated by the close similarity between the average reaction time of 229.02 ms. that was obtained at the 12-second test interval and the average reaction times of 228.69 ms., 227.81 ms., and 231.18ms. obtained on the three immediately preceding standard-interval trials and by the average reaction time of 221.81 ms. obtained on the immediately succeeding standard-interval trial.

Another way of graphically presenting the data obtained in this experiment is to plot each of the reaction-time averages for the group as a whole on the eight test trials in terms of what *percentage* it is of the average of the reaction-time averages obtained on the three (or any other arbitrary number of) standard-interval trials immediately preceding the test trial. This procedure is followed in the broken-line graph that appears in Fig. 7. The first point on this graph, for instance, was determined by dividing 293.57 ms. (average reaction time for all subjects on the three-second test trial) by 227.28 ms. (average of 227.20 ms., 231.88 ms., and 222.76 ms., which were the reaction-time averages for all subjects on the three preceding standard-interval trials). The remaining seven points on this curve were determined in a similar manner. It will be noted that the shape of this curve is almost identical to that of the curve obtained by simply plotting the absolute reaction-time averages, in terms of milliseconds, for the eight test trials (Fig. 6). The similarity of these curves indicates, again, that the "base line", composed of the average reaction times on the standard-interval trials, remained relatively constant throughout.⁷

⁷ It may be well to remind the reader at this point that the eight test trials were interspersed among the last 49 standard-interval trials in a pre-arranged but perfectly balanced, random order for the group as a whole. Any trend shown by the curves presented in Fig. 6 and Fig. 7 cannot, therefore, be due to the order in which the test trials were presented.

There is, moreover, this additional advantage in reproducing the data in this way, that by plotting the reciprocal of the broken-line curve representing reaction time in Fig. 7, it is possible to

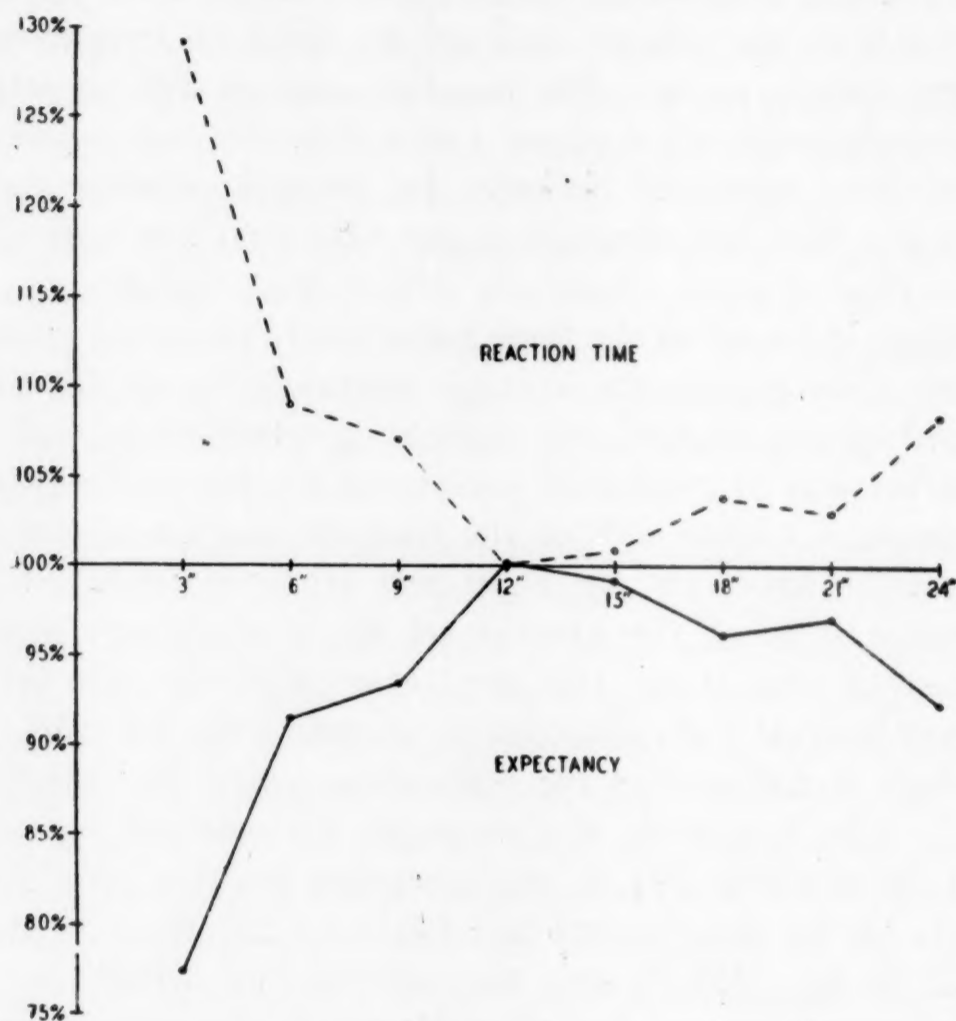


FIG. 7. The dotted-line curve shows the extent (in terms of percentages) by which the average reaction time of 100 male college students on "test" presentations of the reaction stimulus (tone) at the intervals indicated along the abscissa exceeded the average reaction time of the same subjects on the three standard-interval presentations of the stimulus that immediately preceded each "test" presentation. The solid-line curve is the reciprocal of the dotted-line curve and is assumed to represent the course of "expectancy".

obtain a second curve, which, by hypothesis, represents the course of expectancy between successive stimulus events at the standard interval of 12 seconds and which is necessarily also in terms of percentages rather than in absolute units (such as milliseconds) that are not appropriate. This "curve of expectancy" is represented by the solid line in Fig. 7.

The shape of the curve thus derived, from strictly empirical data, confirms the suppositions previously advanced. It shows,

first of all, that when a stimulus event occurs after a standard, recurrent temporal interval and produces an appropriate response, readiness to repeat that response (expectation of the stimulus) immediately drops markedly, then mounts to a maximum at the point in time coinciding with the end of the next standard interval. If the expected stimulus and prepared-for response do not occur at this point, there is, at least under the conditions of this experiment, a relatively gradual decline thereafter in readiness to make such a response, which presumably implies a corresponding decline in expectation of the stimulus. It was previously conjectured that if the stimulus did not occur at the end of the standard interval, the curve of expectancy (readiness) might continue to rise for a little while, before starting to decline. No such tendency is noted in the curve in Fig. 7. It may well be, however, that such a "hump" would be obtained under other experimental conditions, particularly if the expected stimulus event were somewhat more "traumatic" than a tone of moderate intensity can be said to be.⁸

It may be asked whether the sudden lowering of expectancy immediately after the occurrence of an expected stimulus-response sequence may not represent a simple refractory-phase phenomenon of some kind. Under such circumstances the subject is, to be sure, "refractory" in the sense that he shows a reduced readiness to make the response in question (as indicated by increased response latency), but this effect is demonstrably not due to any kind of "physiological limit", which is what the term "refractory

⁸ This supposition is supported, albeit somewhat obliquely, by the fact that a number of investigators (cited by Hovland, 24) have found that after a series of paired presentations of a conditioned and an unconditioned stimulus (the latter usually of a noxious character), the responses obtained on the second and third presentations of the conditioned stimulus alone, unaccompanied by the unconditioned stimulus, are likely to be somewhat larger than the response obtained on the first so-called non-reinforced presentation of the conditioned stimulus. After this initial rise in response magnitude, the size of the reactions to the successive non-reinforcement conditioned stimuli gradually undergoes a decrement, leading to ultimate extinction. Hovland (24) has undertaken an analysis of the conditions under which this effect occurs and has come to the conclusion that it is a function of the accumulation or non-accumulation of "inhibition of reinforcement" during the successive paired presentations of the conditioned and unconditioned stimuli. Humphreys (27, 28, 29) has reported more recent findings which he interprets on the basis of an expectancy hypothesis that accords well with the theoretical position taken in the present paper.

phase" properly implies. Numerous studies⁹ have shown that the most favorable interval between the warning stimulus and the reaction stimulus in simple reaction-time experiments is relatively brief. Woodrow (58), using foreperiods ranging from one to 24 seconds, has studied this problem particularly systematically and found, with earlier investigators, that the fastest reactions occur with a preparatory interval of about two seconds. In the light of this fact it is clear that the longer reaction times obtained in the present study on the three-second test trial than on the standard-interval trials cannot be due to any kind of physical limitation of the reacting organism. However, in order to verify this conclusion under the conditions of the present investigation, a few subjects, after they had served in the main experiment, and had had a brief rest period, were asked to return to the sound-proof room, where they were again seated and given the same instructions as before. But now, instead of being presented with a series of tones at 12-second intervals, they received tones every three seconds. After the first two or three responses, these subjects began to make reactions that were decidedly faster than their reactions had been under the first conditions. If, then, after this new rhythm of expectation was well established (i.e., after reaction times became fairly constant) a 12-second interval was interposed, the latency of the ensuing reaction was always dramatically increased. Such an effect is obviously not explainable in terms of "refractory phase", yet it is strictly comparable to the phenomenon manifested in the main experiment.

In a later report evidence will be presented which shows that under some conditions expectancy apparently occurs as an unlearned phenomenon, but there can be scarcely any question that the particular curve shown in Fig. 7 is a learned phenomenon. Variation in the length of the standard interval between successive presentations of the reaction-evoking stimulus, in the nature and intensity of this stimulus, and in the amount of "practice" permitted before the introduction of test trials would undoubtedly have noticeable effects in this connection. Nevertheless, the curve here presented is probably representative, in a general way, of

⁹ See, for example, those reviewed by Breitwieser (6).

the type of curve obtainable under a variety of circumstances. It is believed that the general shape of this curve, involving a relatively rapid rise to the maximal point and then a more gradual decline, can be derived from the concept of "stimulus traces" and from the principle of "generalization of conditioning", but this, too, will have to be postponed until a later study.

Finally, it may be asked whether there is any difference between the phenomenon of "expectancy" and what has been traditionally connotated by the older term "attention". Since the latter has usually been defined in diffuse, mentalistic terms, on which no two writers could agree, it is difficult to determine whether the "faculty" that "attention" was supposed to represent is or is not the same as such a specific, operationally definable concept as expectancy. For some few writers, it is clear that "attention" prominently involved the notion of preparation for impending action. James (31), for example, in discussing the question as to the "intimate nature of the attentive process", concluded that there are "two physiological processes [which] immediately suggest themselves as possibly forming in combination a complete reply", to wit: "(1) The accommodation or adjustment of the sensory organs; and (2) the anticipatory preparation from within of the ideational centres concerned with the object to which the attention is paid" (p. 434). His use on a subsequent page (439) of such expressions as "anticipatory thinking", "preparation to react", "premonitory imagination", and "expectant attention" leaves little doubt of the similarity of his conception of the so-called "attentive process" and what is here designated as expectancy, or preparatory set.¹⁰ Used in this sense, there can be no objection to regarding "attention" as simply a synonymous term for the phenomenon that is here the primary object of quantitative study. However, an examination of the earlier works that purported to "measure attention" leaves no doubt as to the need for a new attack upon this problem, for new terms, and for a new perspective.¹¹

¹⁰ The writer feels no hesitancy in employing these two latter terms interchangeably. They are assumed to be merely two aspects of the same basic phenomenon.

¹¹ For an excellent review of this literature, see Philip (50); also Whipple (57).

METHOD II—REACTION MAGNITUDE

From a number of incidental observations that have previously been reported,¹² it is evident that under appropriate circumstances the size of the reaction elicited by a standard stimulus affords an index of the extent to which that stimulus is expected and prepared for by the reacting organism. One of the most explicit instances of this type of observation is reported by Pavlov (48), who says:

"The experiment just described [on temporal conditioning in dogs] may be performed with the following modification. The animal can be given food regularly every thirtieth minute, but with the addition, say, of the sound of a metronome a few seconds before the food. The animal is thus stimulated at regular intervals of thirty minutes by a combination of two stimuli, one of which is the time factor and the other the beats of the metronome. In this manner a conditioned reflex is established to a compound stimulus consisting of the sound plus the condition of the hemispheres at the thirtieth minute, when both are reinforced by food. Further, if the sound is now applied not at the thirtieth minute after the preceding feeding, but, say, at the fifth or eighth minute, it entirely fails to produce any alimentary conditioned reflex. If it is applied slightly later it produces some effect; applied at the twentieth minute the effect is greater; at the twenty-fifth minute greater still. At the thirtieth minute the reaction is of course complete" (p. 41).

If the results of this experiment had been presented in precise quantitative terms, i.e., number of drops of saliva elicited by the metronome at the various temporal intervals, so that these values could have been plotted graphically, it is clear that the resulting curve would have started at zero and gradually ascended to a maximum at the standard 30-second interval. Unfortunately, Pavlov gives no account of any attempt having been made in his laboratory to determine how the size of the salivary response would have been affected had the sounding of the metronome been delayed beyond the point at which expectation of feeding was maximal.

Despite the suggestiveness of the findings reported by Pavlov, which have just been described, and of those obtained by other experimenters under widely diverse conditions, it appears that the only systematic and quantitatively exact attempt to investigate response magnitude in relation to a standard interval between successive stimulus presentations was recently made by Brown (8)

¹² See, for example, Darrow (14), Freeman (18), Hilgard and Biel (23), Landis and Hunt (35), and Tuttle (56).

in the same laboratory from which the present study comes. This writer first presented individual rats with 35 instantaneous shocks, which were delivered at regular 12-second intervals from a small, "free-floating" grill on which the animal stood. Following this training series, each animal continued to receive shocks at 12-second intervals, except for occasional test shocks that were administered after intervals of 3, 6, 9, 12, 15, 18, 21, and 24 seconds. These test trials were given in a random, balanced order, and the size of the jump made to each presentation of the shock was linearly recorded by photographic means.

In keeping with the results of the reaction-time experiment reported in the preceding section, Brown found the smallest average magnitude of response at the three-second test interval, with progressively larger responses up to the 12-second test trial. However, on the 15-second test trial, there was a sharp, statistically reliable drop in the average size of reaction, followed by a rise on the 18-second test, a still further rise on the 21-second test, and finally a drop on the 24-second test. It will be recalled that the reaction-time curve for human subjects (Fig. 6) showed no such fluctuations at the longer test intervals, manifesting instead a gradual increase in latency on the successive test intervals longer than the standard interval. If subsequent research confirms this difference between the shape of the "expectancy curve"¹³ obtained from human beings and from rats, it may be found explainable on the grounds that the symbolic processes (speech) causes a kind of perseveration of readiness in human beings that is not possible in rats. It is noteworthy that the drop obtained by Brown in the magnitude of response on the 15-second test trial comes at a point at which expectancy would have been lowest if stimulation had occurred at the standard interval, i.e., three seconds beyond the 12-second interval. If this drop obtained by Brown on the 15-second test interval is confirmed, it will have extensive theoretical implications which cannot, however, be pertinently gone into at this time.

¹³ Mention should be made of the fact that Brown interpreted his data as showing the operation of a "temporal gradient of reinforcement" rather than as an "expectancy curve". However, since the present writer assumes that expectancy is developed on the basis of the former principle, there is no basic incompatibility between the findings or the implications of the two studies.

The findings that are now to be described were obtained in an as yet unpublished investigation which was carried out by Professor Clark L. Hull, with quite a different objective in view than the present one, namely, the conditioning of the galvanic skin reaction of human beings to a "patterned" stimulus. At the suggestion of Dr. Douglas G. Ellson and with the kind per-

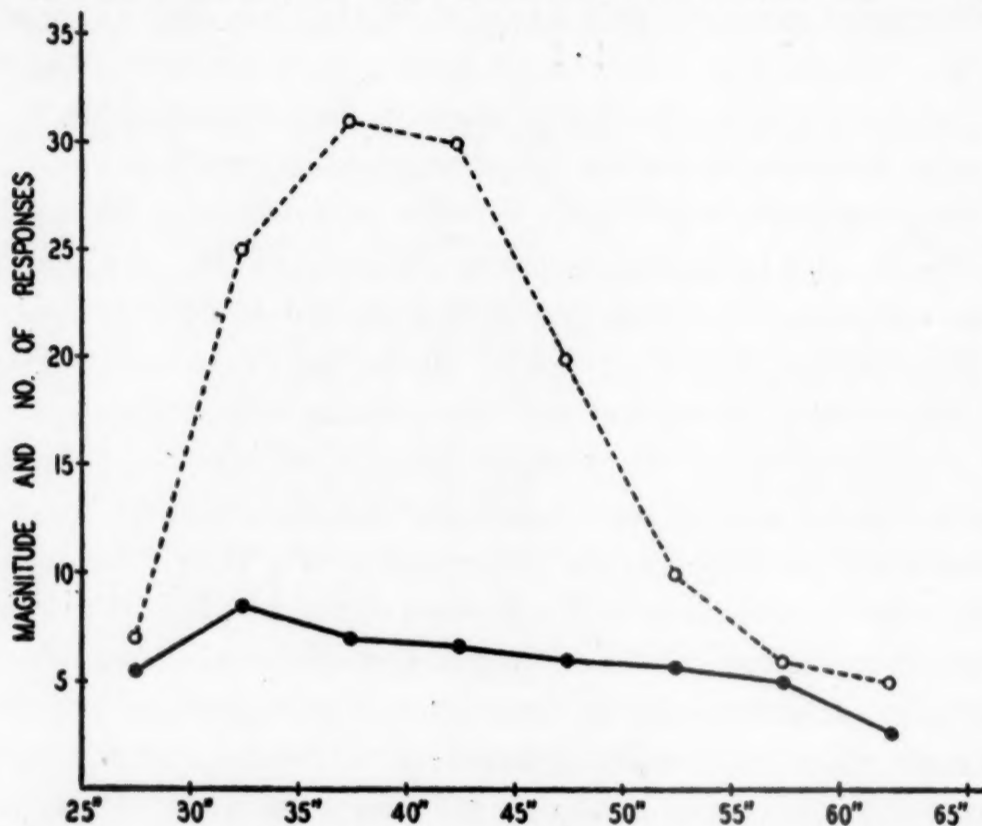


FIG. 8. The solid-line curve represents the average magnitude of galvanic skin response elicited by a conditioned stimulus, presented at the various temporal intervals indicated (along the abscissa) after the preceding stimulus-response sequence. The dotted-line curve represents the frequency with which the conditioned stimulus occurred at these intervals. The data (obtained through the courtesy of Professor Clark L. Hull) on which these curves are based represent the responses of eight human subjects during a single experimental session.

mission of Professor Hull, the writer has analyzed the results of this study in terms of the magnitude of response as a function of the amount of time elapsing between successive stimulus presentations. Since the responses were sometimes elicited as conditioned reactions, i.e., by the conditioned stimulus alone, and sometimes as unconditioned reactions, i.e., by the conditioned and unconditioned stimulus (shock) in combination, it is desirable to present the data obtained under the two conditions in separate graphs. The solid-line curve in Fig. 8 shows the average magni-

tude of the *conditioned* responses obtained at the step intervals shown along the abscissa, which represent the time in seconds since the preceding stimulus presentation. The broken-line curve, on the other hand, shows the frequency with which presentation of the conditioned stimulus occurred at the various step intervals. Although the correspondence is not perfect, it will be noted that in general the largest magnitude of response was obtained when the conditioned stimulus was presented at the most commonly used intervals, i.e., between 30 and 50 seconds after the last stimulus presentation. When a stimulus was presented at an uncommon temporal interval (shorter than 30 seconds or longer than 50 seconds), the size of the reaction was appropriately diminished, thus indicating, according to the writer's interpretation, that the magnitude of the conditioned G. S. R. obtained under these circumstances was positively correlated with the degree to which stimulation was expected by the subjects.

Casual inspection of the data constituting the solid-line graph in Fig. 8 indicates that the differences between successive points on the curve are probably in no case reliable, as measured by usual statistical devices. However, the smoothness of the curve warrants placing considerable confidence in its significance.

The size of the *unconditioned* G. S. R., as a function of the temporal interval elapsing since the preceding stimulus presentation, is represented by the solid-line curve in Fig. 9. The dotted-line curve shows the frequency with which the unconditioned stimulus was presented at the various step intervals. As in the case of the conditioned G. S. R., the magnitude of the unconditioned G. S. R. also shows a positive correlation with the point in time at which the subjects had empirical grounds for most strongly expecting stimulation. Here again there is probably not a reliable difference between any two successive points on the solid-line curve as measured by usual statistical methods, but the tendency for this curve to follow the distribution curve is extremely suggestive.

By using a procedure similar to that employed by the present writer in connection with the study of reaction time reported in the preceding section or by Brown in the study of response

magnitude already described in this section, it seems virtually certain that the magnitude of the G. S. R., produced by a standard stimulus, could be used as a highly reliable and refined measure of expectancy of that stimulus. It will be noted, however, that this statement is not inconsistent with the remark made in the introductory section to the effect that the G. S. R., along with the other "physiological changes", is not a very

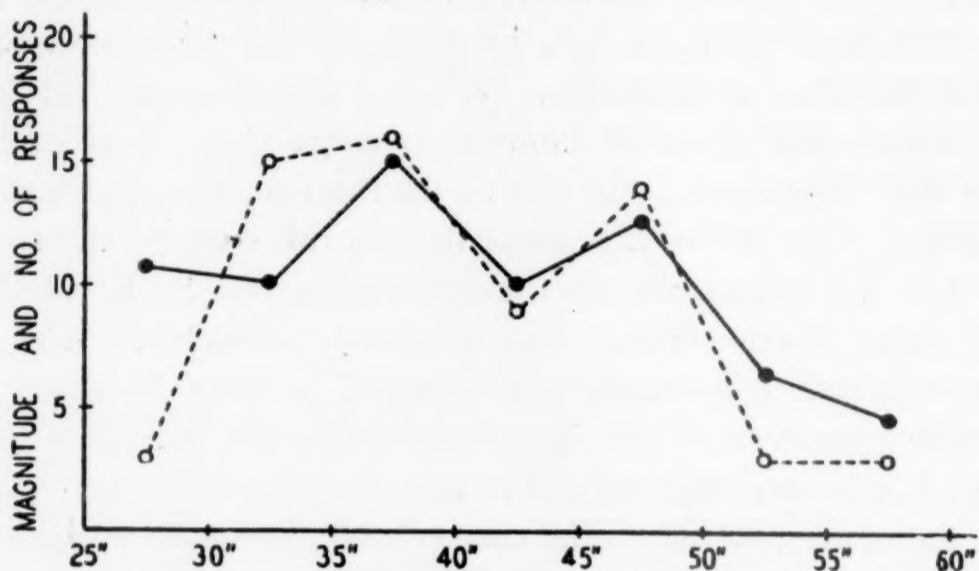


FIG. 9. The solid-line curve represents the average magnitude of the G. S. R. elicited by an unconditioned stimulus (shock) when presented at the various temporal intervals indicated after the preceding stimulus-response sequence. The dotted-line curve represents the frequency with which the unconditioned stimulus occurred at these intervals. The data on which these curves are based were obtained under the conditions stated in the legend to Fig. 8.

adequate *direct* measure of expectancy. The method that is elaborated here consists, not in relying upon the galvanic skin resistance (or potential) to change concomitantly with expectancy, but rather, in using the size of the reaction produced by a *standard stimulus* as a measure of this phenomenon. Evidence published elsewhere (43) indicates that expectancy can change within broad limits without this being at all evident in the G. S. R. "baseline". It is only, in other words, when expectancy or, to use another term proposed by Darrow (14), the "excitation background" is sampled, or "tapped", in the manner here indicated that the G. S. R. takes on a high degree of refinement as a measure of this phenomenon.

The use of the magnitude of the response made to a standard

stimulus as a measure of expectation of that stimulus would thus appear to open up new research possibilities of some importance. However, one complication can already be anticipated, namely, that a positive correlation between response magnitude and expectancy will be found only in those cases in which there is a "positive attitude" on the part of the subjects, i.e., a set to perform the response in question when the expected stimulus occurs rather than a set not to perform it ("negative attitude"). One of the great difficulties in attempting to use the conditioned-response technique with human beings is that, because of complex social habits which the experimenter often cannot or at least does not control, subjects spontaneously adopt a negative attitude toward the conditioned stimulus, the unconditioned stimulus, or both. Miller (22), for example, obtained approximately the same amount of eyelid conditioning in human subjects when he told them to try their best not to make a response to the conditioned stimulus as when he gave them no instructions whatever on this score. In many experimental situations, a conditioned response seems "foolish" or even "cowardly" to human subjects and they put themselves on guard against being "shown up". It is an obviously necessary precaution, therefore, in attempting to use response magnitude as a measure of expectancy to bear in mind that the correlation between the size of the response and the degree to which the stimulus that elicits the response is expected may be either positive or negative, depending upon the character of the prevailing "attitude" or "set" of the subject.¹⁴

¹⁴ It might appear that there is here a basis for questioning the parallelism between expectancy and preparatory set that is implied in the title of this study and is explicitly posited at various points in the text. If preparatory set can be either "positive" or "negative", with expectancy in both cases "positive", then the two must be independent phenomena, not simply different aspects of the same phenomenon. This difficulty disappears, however, when it is recalled that a so-called "negative" attitude or set is quite as *active* a state, when viewed psycho-physiologically, as is a "positive" set and that the terms "positive" and "negative" are meaningful in this context only with reference to one particular, selected type of performance. With reference to some other (usually antagonistic) type of performance, a so-called "negative" set is, necessarily, "positive". Viewed in this light, expectancy is always positively correlated and varies concomitantly with preparatory set, providing the behavior for which the latter is appropriate is properly defined.

A further indication of the rôle of negative attitude on the part of human subjects in certain types of conditioning experiments is the finding, reported by Calvin (10), that better eyelid conditioning is obtained with an irregular interval between successive paired presentations of the conditioned and unconditioned stimulus than with a regular interval. On the basis of the principle of "temporal conditioning", better conditioning would have been predicted in the latter case. As the present writer views the matter, the reverse finding can only mean that the subjects in this study had a strongly negative attitude toward blinking in response to the conditioned stimulus and that this attitude was able to manifest itself most effectively when the occurrence of the conditioned stimulus was anticipated with a relatively high degree of accuracy (thus, giving inferior "conditioning" at the regular intervals). On the other hand, when the paired presentations came at irregular intervals, with resulting inability on the part of the subjects to know exactly when to expect stimulation, they were often caught "off guard" and blinked "in spite of themselves" (thus, giving superior "conditioning").¹⁵ On the assumption that animals lower than man would not have the same incentives as human beings for manifesting a negative attitude in a conditioning experiment of this kind, it would be very instructive to repeat Calvin's experiment with animal subjects. This should provide a reasonably crucial test of the validity of the interpretation that has just been proposed of the findings reported by this investigator.

It is not to be supposed, however, that because infra-human organisms are less disposed to show negative attitudes toward what would seem to be natural reaction tendencies (i.e., are less

¹⁵ Support for such an interpretation is found in a recent study by Yacorzynski and Guthrie (61). They say: "There is evidence that the conditioned voluntary response [which was here investigated] appears oftener when the interval is unusually long or short. The subject is then caught off his guard because the inhibitory set [spontaneously established by the subjects] is also conditioned with its time interval. Furthermore the conditioned voluntary response according to our records starts strong, diminishes after an 'error' [i.e., a 'conditioned response'] and then builds up increased certainty until another 'error' occurs with a consequent decrease in certainty of response. . . . Many subjects reported that after being once taken by surprise in this 'error' their whole attention was given to keep from being 'caught' again" (pp. 251-253).

"inhibited") than are human beings that this type of phenomenon is altogether absent in them. By means of appropriate "conflict" situations, a wide variety of such attitudes could presumably be created at will. Ellson (16) has, in fact, already called attention to what would appear to be an excellent instance of this kind, all the more dramatic because of its subtlety. In an experiment conducted by Ivanov-Smolensky, which is reported by Pavlov (48), the salivary reaction was independently conditioned to two tones of different pitch. The conditioned reaction to one of these tones was then repeatedly extinguished and the size of the reaction to the other tone tested at varying intervals after the last of a series of non-reinforced presentations of the first tone. Pavlov says that "all the reflexes [to the second tone] were found to undergo inhibition, but in a varying degree" (p. 165). Ellson has taken some of the results obtained in this experiment, which Pavlov presents tabularly, and has arranged them graphically in the form of two curves. With this writer's generous permission, these two curves are reproduced in Fig. 10. From these it will be seen that when the second (non-extinguished) tone was presented 0 minutes and one minute after the last non-reinforced presentation of the extinguished tone, a significant reaction was obtained, whereas at the end of three minutes and again at five minutes there was relatively little response. At the end of 10 minutes the non-extinguished tone again produced a sizable reaction and a still larger reaction at the end of 15 minutes. Pavlov interpreted the smallness of response produced by the non-extinguished tone at the three-minute and at the five-minute intervals after extinction of the other tone as meaning that this was the amount of time required for the "inhibitory process" supposedly generated by the extinction of the conditioned reaction to the first tone to "irradiate" from its point of initiation at one cortical locus out over the rest of the "acoustic analyzer". The greater magnitude of response obtained after the longer intervals of delay Pavlov explained as due to the "inhibitory process" having presumably irradiated maximally and then having "receded" before the occurrence of the second tone.

Ellson pertinently notes that the interval between successive paired presentations of conditioned and unconditioned stimuli used in Pavlov's laboratory frequently ranged between three and

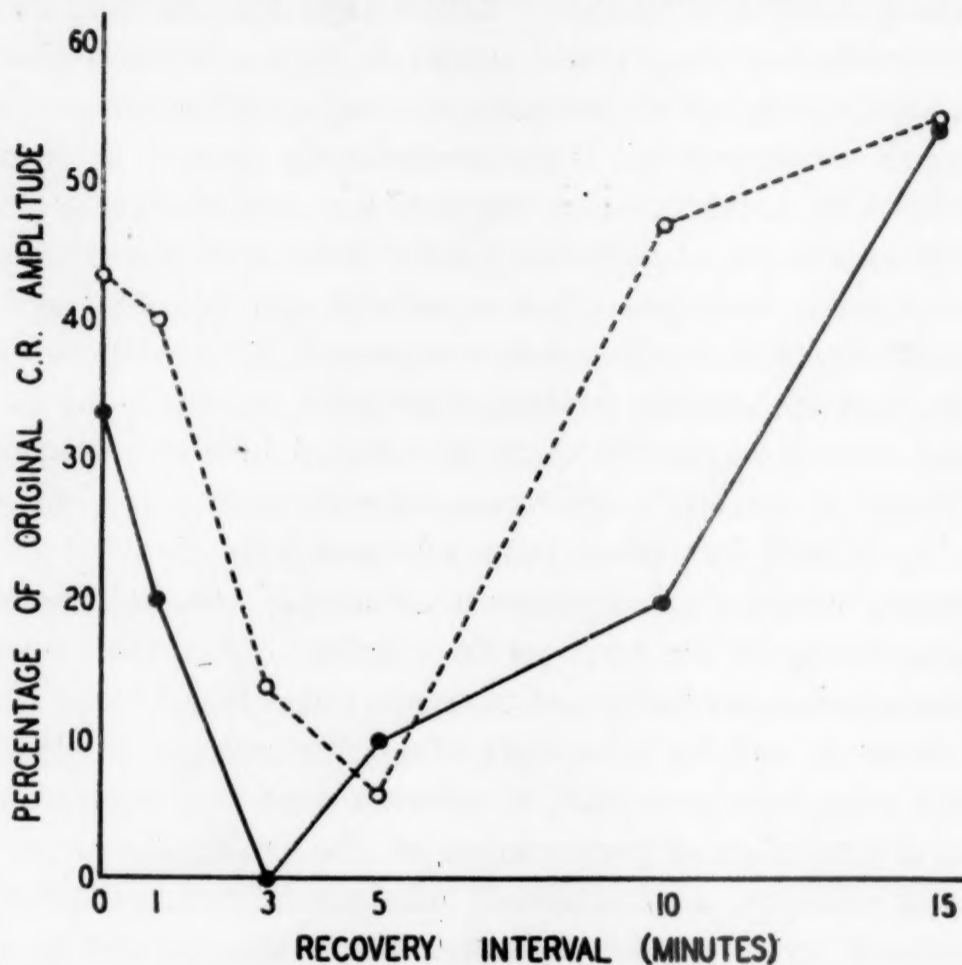


FIG. 10. Both curves in the above figure (based on data obtained from Pavlov, 48) show the varying extent to which the extinction of a conditioned salivary response to a tone of one pitch inhibits the conditioned reaction to a tone of another pitch when the latter tone is presented at various temporal intervals after the extinction of the response to the first tone. According to the interpretation suggested in the text, the maximal depression of the conditioned reaction to the second, non-extinguished tone occurs at the three- and five-minute intervals after extinction of the response to the first tone for the reason that the successive non-reinforced presentations of the first tone probably also occurred at approximately these intervals (Ellson, 16). It was therefore at these intervals that the animal's expectation of food was lowest and its "negative attitude" toward all conditioned stimuli (signals of food) strongest.

five minutes. On the assumption (i) that this was the rate used in establishing the conditioned salivary reactions in the experiment under discussion and (ii) that it was also the rate at which the conditioned reaction to the one tone was systematically extinguished, it is easy to see why the conditioned reaction to the

second, non-extinguished tone was minimal when elicited at the end of the three and five-minute intervals. It was precisely at these intervals that, as a result of the repeated non-reinforced presentation of the first tone, expectation of food was lowest. Consequently the magnitude of the salivary reaction made to all stimuli would tend to be especially small at just this time. At other points, both before and after this one, there would presumably be a somewhat less accentuated "negative attitude" and other stimuli would have a proportionately greater effect. In other words, the curves reproduced from Ellson in Fig. 10 may be said to portray the curve of expectancy during a period when it drops to a minimum instead of rising to a maximum, as it did, for example, in the Pavlovian experiment described at the outset of this section.

This interpretation may seem somewhat hypothetical, and it will certainly need to be buttressed by further research before complete dependence can be placed on it. It shows, however, the ramified implications of the expectancy concept and demonstrates its possible usefulness as a means of eliminating the dubious "brain physiology" of Pavlov as an explanatory basis for many important empirical observations.

METHOD III—IMPLICIT CONDITIONING

In an earlier study (43), a distinction was drawn between new stimulus-response sequences that appear (i) because of genuine learning and (ii) because of the development of preparatory sets, or states of readiness, to such a point that they can be "tripped" and transformed into overt action by stimuli which, without such a background of preparedness, would not ordinarily produce a response of this kind.¹⁶ At that time the supposition was also advanced that the phenomenon of conditioning, as it is somewhat loosely conceived, is sometimes dependent for its occurrence upon one of these mechanisms, sometimes upon the other. To the extent that conditioning in any particular experimental situation is dependent upon the second of these mechanisms it is, in effect,

¹⁶ Cf. Hull's distinction between what he has termed Alpha conditioning and Beta conditioning (26).

an index of the underlying state of the organism that is here termed expectancy or set. There has already been occasion in the preceding section to refer to experimental situations in which the magnitude of conditioned responses does indeed afford a reasonably satisfactory measure of this phenomenon. In many types of situations, however, conditioned reactions of an overt, easily observed character are relatively slow to manifest themselves and are decidedly unstable. This can scarcely mean that in these instances—sometimes involving hundreds of successive presentations of paired stimuli—the first of the pair, the so-called secondary, or conditioned, stimulus, has acquired no meaning, no signal value, no significance to the organism. It is, in other words, extremely unlikely in such cases that the subject does not “know” that the one stimulus, of an intrinsically innocuous nature, is to be followed by another, less innocuous stimulus. In situations in which the occurrence of a conditioned reaction has no “defence” value, i.e., does not enable the organism to avoid or at least diminish the intensity of the noxious, unconditioned stimulus, the failure of conditioning is not very mystifying. However, the writer has observed a number of cases in which rats and other laboratory animals (sometimes even human subjects) fail to develop conditioned reactions under the seemingly optimally favorable condition of such a reaction providing the possibility of avoiding the unconditioned stimulus completely.

Such a failure of conditioning seems to be a regular occurrence under the following circumstances. If a rat is placed on a grill that can be momentarily energized with electricity and if on each occasion that the resulting shock is presented a tone of moderate intensity is sounded for one second in advance, never will the rat, even after innumerable presentations of tone and shock in combination, make a quick, decisive jump in response to the tone of the kind that it makes to the shock.

This is not an appropriate time to try to determine what precisely is the reason for the failure of conditioning under the circumstances just described, but it is certainly not attributable to sheer stupidity on the part of the rat. After as few as two or three paired presentations of the conditioned and the uncon-

ditioned stimuli, one can observe reactions, such as flattening of the ears and disturbed breathing, that clearly indicate that the tone has become a signal of impending shock. That the tone produces a definite expectancy of (readiness for) shock can, moreover, be further demonstrated by the following procedure.

If, after a number of paired presentations of tone and shock at a standard rate, the shock is presented at the usual time but is not preceded by the tone, the size of the reaction produced thereby is likely to be materially smaller than the reactions made to the joint presentations of tone and shock that precede and follow. The upper record in Fig. 11 shows a series of jumping responses made by a rat to tone and shock in combination, with an occasional interpolated shock without tone. It will be noted that when the shock comes, as it were, without warning, the size of the resulting jump is greatly reduced.¹⁷ The lower record in Fig. 11 shows the complete ineffectualness, on the other hand, of the tone alone as far as the production of a jump, as a conditioned response, is concerned.¹⁸ This augmentation of the reaction to the *unconditioned* stimulus, by virtue of its being preceded by a warning, or conditioned, stimulus (which does not, however, produce a gross, overt response in its own right), is here termed "implicit conditioning".

Data affording an opportunity for exact, quantitative comparison of the magnitude of response obtained with and without the warning signal—from which the expectancy-producing efficacy of the signal could be determined—was not obtained for the reason that comparable responses could be produced only so long as the rat remained in approximately the same position on the grill. If the animal turned, for example, from a position in which the long axis of its body was at right angles to the small individual steel rods constituting the grill to a position in which the long axis of its body was parallel to the bars, a somewhat

¹⁷ A comparable effect can, of course, be readily demonstrated in human subjects with respect to the latency of a simple reaction by occasionally presenting the reaction stimulus without the warning stimulus that has ordinarily preceded it on prior presentations.

¹⁸ The mechanical details of the method by which these records were obtained have been given in another paper (44) and will not be repeated here.

different intensity of shock was almost certain to be experienced, with a resulting change in the magnitude of response thereby produced. The two records that are reproduced in Fig. 11 were obtained from animals that remained in virtually the same location with reference to the grill during the succession of stimulations indicated. The relatively great amount of variability arising from alterations in the rat's location on the grill would have so obscured the differential effect of shock with and without the warning signal that the results obtained would probably have been statistically unreliable, if all reactions had been included. If all reactions had not been included, the application of statistical method would, of course, have been a travesty. Since the effect of the warning signal was, however, so striking when an animal did not change its position (as the upper record in Fig. 11 shows), it seemed better to make no attempt at exact quantification until other techniques have been worked out for investigating this phenomenon which do not involve such a large element of uncontrolled error. Such techniques can undoubtedly be devised.

METHOD IV—ELECTRO-ENCEPHALOGRAPHY

The methods of objectively investigating expectancy that have been discussed in the preceding sections, while relatively satisfactory in some respects, have one common defect: they do not provide a means whereby the course of this phenomenon can be continuously followed in a single, individual subject. For some purposes the possibility of obtaining such a record would be highly desirable; fortunately, this possibility seems at last to be at hand, in the form of the electro-encephalogram or so-called "brain waves" of Berger. Experimental attempts have repeatedly been made to correlate the presence or absence of these rhythmical electrical pulsations from the cerebral cortex with the presence or absence of various kinds of sensory stimulation or muscular activity, such as clenching the fists, talking, and so forth. The somewhat disconcerting finding has been, however, that no such correlation of a one-to-one, unvarying character exists, with the result that many have come to regard the Berger rhythms and their coming and going as an interesting but as yet

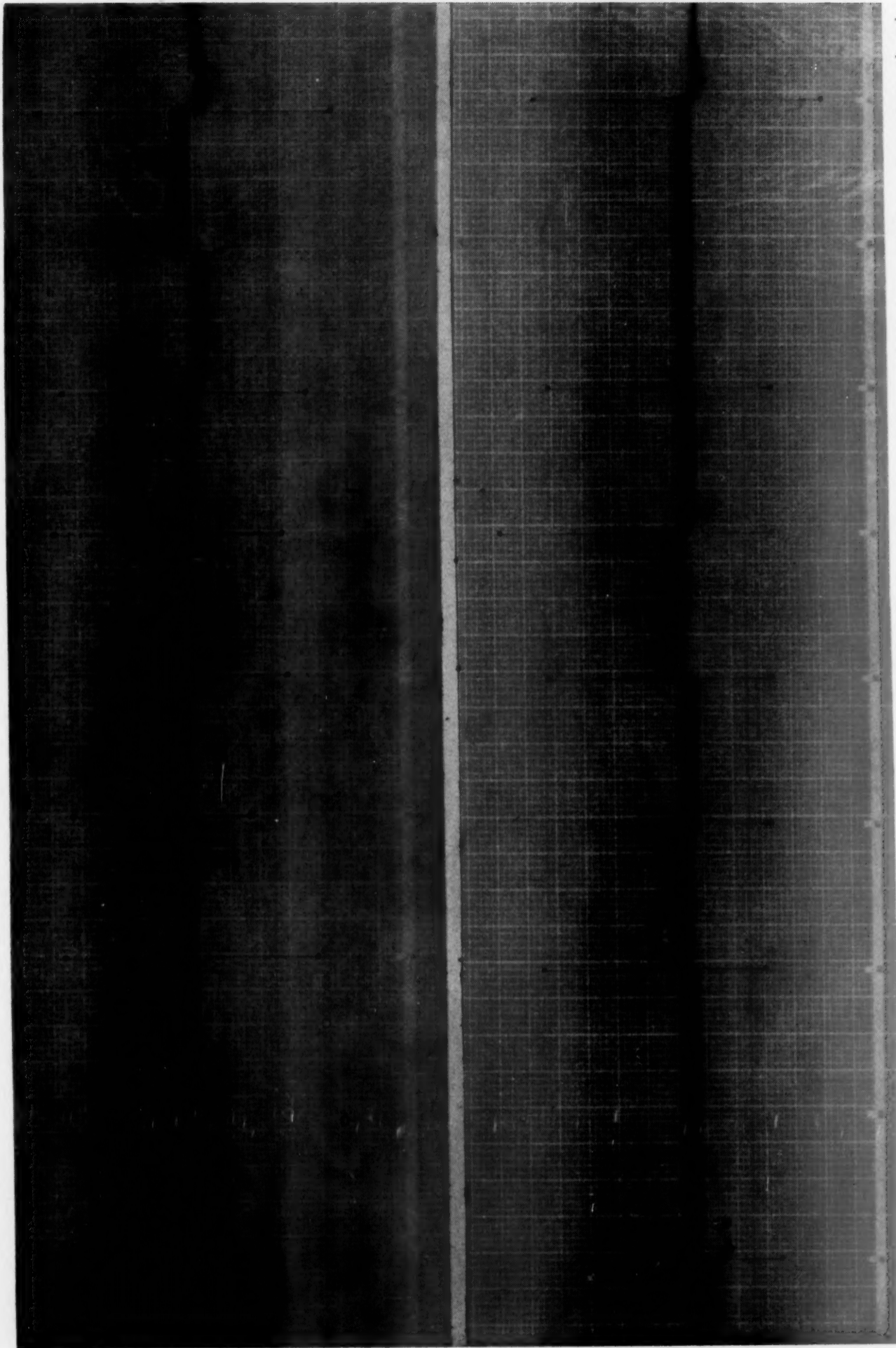


FIG. 11. The vertical black lines in the upper record show the magnitude of nine successive jumps produced in a rat by a momentary electric shock of standard intensity applied regularly every 20 seconds through the grill on which the animal was standing. All presentations of shock, except the second and eighth, were immediately preceded by a tone of one second's duration (see white line at bottom of record). It will be noted that the magnitude of jump to shock when preceded by tone was much greater than when not preceded by tone, thus indicating "implicit conditioning". The lower record shows the failure of the tone alone to produce a detectable overt reaction. The small dots at the ends of the lines indicating magnitude of jump were added to the original records in order that their legibility not be lost in reproduction.



rather meaningless curiosity. On the other hand, those investigators who have worked most intensively in this field have maintained that, despite the superficially capricious nature of these electrical effects, they correspond to psychologically significant states of the nervous system. This point of view is well represented in the following quotation from Jasper (32):

"The idea of levels of cortical excitatory state or of cortical activation is admittedly a rather vague concept, but it has proven of value as a working hypothesis for the purposes of describing certain systematic changes in cortical potential patterns associated with conditions of the organism usually described by the terms 'excited', 'aroused', 'emotionally tense', 'very alert', 'intense concentration' (of attention), etc., as opposed to conditions of relaxation, drowsiness, and sleep. . . . It was first pointed out by Berger and later confirmed by many investigators that, in general, the maximal regularity and amplitude of the alpha rhythm in man is observed under optimal conditions of relaxation. Intense worry, emotional excitement, or severe apprehension often results in apparent suppression of the alpha rhythm except for rare groups of waves in a long record" (pp. 456-457).

It does not appear to be an unreasonable assumption that the "cortical excitatory state" that this writer here proposes as the negative correlate of Berger rhythms is the same phenomenon that has been referred to throughout the present study as expectancy or preparatory set. Perhaps the best evidence in support of this supposition is the fact that the temporarily depressing effect that certain forms of stimulation have upon the principle, or "alpha", type of brain waves can be readily "conditioned" to stimuli that initially have no such effect. In an investigation by Cruikshank (13) it was necessary to give a "preparatory signal" consisting of the command, "Eyes open", before presentation of a visual stimulus, the inhibiting effects of the latter on the alpha waves being the main object of experimental interest. The use of such a signal was found highly unsatisfactory from the point of view of the main purpose of the experiment for the reason that "after two or three presentations of the preparatory signal at a constant interval before the light the brain potentials would become conditioned to react to the preparatory signal before the light flash. The auditory signal itself would have no appreciable effect on the brain potentials before this conditioning. . . . The preparatory signal was necessary in order to make the position of the eyes and the general attitude of

the subject more constant from one stimulus to the next" (p. 627). Incidental observations of a similar character have also been reported by Loomis, Harvey, and Hobart (38) and by Howard (25). Travis and Egan (55) have recently investigated this phenomenon more systematically than had previous investigators, but with essentially the same findings. They say: "The statistically significant increase in effectiveness of tone during the conditioning series as compared to that of tone alone, pre-conditioning, is the essential finding of this study" (p. 526). In an unpublished exploratory study by the writer, it has been found that a tone likewise quickly acquires the capacity to depress the alpha rhythm if it is paired with an electric shock, rather than with a visual stimulus. So-called "verbal conditioning" was even found to be obtainable by simply *telling* a subject, after a series of tones without shock, that on the next presentation of tone, shock would shortly follow.

Also significant in this connection is the finding, reported by various writers, (1), (3), (15), (25), that visual stimulation *per se*, which has sometimes been regarded as the necessary cause of alpha-rhythm depression, will have such an effect only when it is "meaningful". As Russell (51) has pointed out, a stimulus event is said to be "meaningful" when it has symbolic implications, i.e., is a signal or sign of something else. Employing the basic conditioned-response formula of Pavlov, this writer says: "Originally, stimulus A produced reaction C; now stimulus B produces it, as a result of association. Thus B has become a 'sign' of A, in the sense that it causes the behavior appropriate to A. All sorts of things may be signs of other things, but with human beings words are the supreme example of signs" (p. 82). In other words, therefore, a "meaningful" stimulus, visual or otherwise, is one that arouses an expectation of consequences ("unconditioned stimuli") that are important to the organism in their own right, i.e., are possessed of *intrinsic* response-producing potentialities. The fact that visual stimulation produces a depression of the alpha rhythm in human beings more frequently than do other forms of stimulation can only indicate, according to this interpretation, that visual stimuli, in general,

are more meaningful. Jasper (32), in discussing this problem, has reached the following conclusion:

"The prepotency of visual stimuli in this regard for man may be related to the behavioral significance of vision at the higher levels of encephalization of function rather than there being a specific relation of the alpha rhythm to the visual mechanism as such. . . . It is interesting to note that a sound imitating the rat's squeal was found most effective in blocking the slow cortical potentials in the rat, according to Travis and Milisen, and that tactual and auditory stimuli were more effective than visual stimuli in blocking the slow rhythms in the cat, according to Rheinberger and Jasper" (p. 466).¹⁹

Rheinberger and Jasper (49) have reported an observation that seems to afford an especially neat illustration of the point that stimuli which depress brain potentials do so by virtue of their arousal of a state of expectancy. They found, quite by chance, that a cat will usually stop showing the alpha rhythm if, during an experimental session, it develops a need for elimination. One has only to recall the type of treatment to which most cats are subjected at one time or another for indiscrete elimination in order to see why such a form of internal stimulation might be highly "symbolic" for the cat, arousing a lively anticipation or expectancy of punishment.

Only one fact thus far reported in the literature seems to oppose the hypothesis that large, regular alpha waves signify mental relaxation and that small, depressed waves signify alertness and expectation. This is the finding, reported by Bagchi (3), Jasper, Cruikshank, and Howard (33), and others, that a stimulus which occurs "unexpectedly", with a "startle" effect, is more likely to depress the alpha rhythm than is the same stimulus if the subject is thoroughly adapted to it. Does not such a finding show, contrary to the foregoing hypothesis, that the more a stimulus is expected the *less* effect it is likely to have on the alpha rhythm? This apparent dilemma breaks down when it is recalled that the statement that a person is adapted to the occurrence of a given stimulus event is not the same as saying that he *expects* it. As the term expectancy is employed

¹⁹ The visual-mindedness of man is indicated by such expressions as "insight", "foresight", "far-sighted", and "to see", meaning "to understand". For a further discussion of this subject and a comparison of man and the lower animals on this score, see Collins (11) and Smith (54).

in the present paper, it implies a state of active preparedness for a given type of stimulus-response sequence. Adaptation is the antithesis of this. It implies that a particular stimulus or stimulus situation has lost its "meaningfulness", that the reaction formerly made to it has, in conditioned-response terminology, become "extinguished". Thus the statement that an "unexpected" stimulus is especially likely to be followed by a depression of the brain potentials really means that such a stimulus is especially likely to be "meaningful" to the subject, i.e., especially likely to arouse a state of expectancy, in a way that an "adapted" ("extinguished") stimulus would not.

In spite of the large number of other factors that have been systematically explored in respect to their possible rôle in facilitating or depressing the electrical potentials of the cortex, it appears from the foregoing discussion that the variable that is probably most significant in this connection has as yet been studied only incidentally, in a sense, largely inadvertently.²⁰ The reasons for this are understandable. Before a phenomenon can become a satisfactory object of scientific inquiry, it must be capable of being (i) controlled and (ii) measured. The present paper is intended as a step in the direction of making the phenomenon of preparatory set or expectancy scientifically amenable in these respects. To the extent that the techniques previously discussed and illustrated in this paper offer an opportunity for the control and measurement of this phenomenon, the way should be open for crucial verification of the major hypothesis that has been under consideration in the present section, namely, that expectancy varies inversely with the size and regularity of the type of brain wave designated as the alpha rhythm. Since the course of expectancy between successive stimulus events that occur at regular intervals has now been empirically, if somewhat laboriously, determined by the reaction-time technique (and confirmed by the other methods already considered), it would be a simple but highly useful task to determine the course of the alpha

²⁰ The nearest to a systematic attempt that has apparently been made to date to investigate the effect of expectancy or set upon brain waves is the study recently reported by Knott (34). See also Bakes (4).

rhythm under the same conditions. Confirmation by such a method of the hypothesis stated above would not only bring new order into the field of electro-encephalography, but it would also open up new possibilities for the more intimate study of a variety of problems that emerge from the theory of expectancy as a motivating and reinforcing agent that has been proposed by the writer (43).

OTHER METHODS

Although less directly applicable to the empirical measurement of expectancy than the techniques discussed in the four preceding sections, there are a number of other possibilities in this connection that may be briefly outlined.

Sensory Hallucinations—It has repeatedly been noted in research on absolute sensory thresholds in human beings that if at a point in time at which the presentation of a stimulus is expected by the subject no stimulation is given, an hallucinatory perception of stimulation is very likely to be reported. Attention has also frequently been called to the fact that simple sensory hallucinations can often be produced in human beings by the use of suggestion, i.e., by the establishment of a strong expectation of stimulation of a given kind by verbal means. This relationship between expectancy and sensory experience has been considered at greater length in an earlier paper (43) and need not be further discussed here, except to say that it apparently affords an opportunity for the detection of expectancy that has not been as yet systematically explored. How useful such an index might prove to be for quantitative purposes is at present conjectural.

The Time Error—One of the commonest sources of annoyance in the field of psychophysical comparisons is the fact that of two stimuli presented in succession, the latter is likely to be consistently overestimated by a slight amount. In seeking to explain this so-called negative time error it has been necessary to raise the basic question as to how the intensity of two stimuli, presented serially, can be compared at all. The first stimulus has disappeared before the second occurs. How, therefore, can a sensation that no longer exists be compared with one that is

current? The hypothesis most widely accepted in this connection is derived from the work of Müller and Schumann (47) on weight lifting. Their supposition was that the lifting of a weight of given mass establishes a set (*Einstellung*) appropriate to the lifting of a second weight of the same mass. The next weight actually lifted is, therefore, judged as lighter or heavier than the first in terms of whether the set is more than adequate or less than adequate for the lifting of the second weight. In order to explain the time error, Woodworth (59) has assumed that a certain amount of effort is required to maintain a given set and that with the passage of time such a set tends to "sag", i.e., to become progressively less adequate for the lifting of a weight of the same mass as the weight first lifted. The result would be that of two weights of identical mass lifted in succession, the second would, on the average, be judged as heavier and that a constant error in the same direction would be introduced in the judgment of successively lifted weights of different mass. This explanation of the time error is supported by the fact that it tends to become greater as the comparison interval is increased and by other facts too complex to be discussed in the present connection. It is only necessary to note here that if this hypothesis is correct, the time error should provide a basis for the study of expectancy inasmuch as it is regarded as a necessary correlate of preparatory set.

"Association" and "Projection" Techniques—Psychological conflict has been defined (39), at its simplest level, as readiness to react to the same stimulus in contradictory ways, with one of these reaction tendencies dominant and the other subordinate. Even the most smoothly coördinated of human behavior probably involves an under-current of conflict, but so long as the discrepancy in the strength of rival reaction tendencies is relatively great, little importance or interest attaches to this state of affairs. When, however, opposing impulses are more nearly matched, the submerged one is likely to exert its influence either by diminishing the smoothness and efficiency of the main stream of integrated behavior or by extruding itself in the superficially meaningless acts known as "symptoms". Under the latter

circumstances the affected individual is often unable to account for his own excentricities and, disturbed by this, seeks the aid of persons who are specialists in the use of various techniques that have been developed during recent decades for the purpose of "unmasking" troublesome impulses. The well-known "association test" was one of the earliest devices developed in this connection. More recently the so-called "projection" techniques have emerged. Psychoanalysis is yet another method of achieving the same end. But regardless of the particular technique employed, the finding is essentially the same: inhibitions always involve expectations (conscious or unconscious) of inimical consequences if the inhibited impulse were allowed forthright expression. Thus, the investigation of submerged, conflicting behavior trends is necessarily a study of expectancy, of the source and objects of anxiety.

"Hypothesis" Formation—If, on a series of occasions, experimentally controllable event X has uniformly been followed in the experience of a given individual by experimentally controllable event Y, and if that individual has been asked to indicate on each occurrence of event X whether he does or does not expect it to be followed by event Y, he will soon be expressing uniformly positive expectations. If event X now ceases to be followed by event Y, the subject will express a few "false" positive expectations and will then abruptly begin to express uniformly negative expectations. This change from what may be termed a strongly positive "hypothesis" to a strongly negative one presumably occurs by degrees, but the all-or-none method of responding that is imposed upon the subject by the conditions of the experiment conceals all indication of the gradualness of this transition. If, however, the results obtained from a *large number* of persons under the same conditions are analyzed, i.e., if the number of "yes" and "no" votes is tabulated on each successive occurrence of event X, it will be found that the change from the positive to the negative "hypothesis" is not abrupt, for the group as a whole. Humphreys (27) and Humphreys, Miller, and Ellson (30) have recently conducted experiments of this kind and have presented curves portraying group changes in "hypothe-

sis", or "attitude", which probably parallel the changes in the *degree of certainty* felt by each individual subject in expressing his expectations during the transitional period. This is a new and interesting possibility as far as the objective measurement of expectancy is concerned. How valid it is remains to be determined. If, for example, the Gestalt contention that changes in "hypothesis" (expectancy) always occur suddenly, through "insight", is correct, then the apparent gradualness of the transition from one hypothesis to another that is suggested by the experiments cited is purely an artifact. The other experimental findings presented in this paper suggest, however, that this is probably not the case.

"Incentive" as a Measure of Expectancy—In a number of studies it has been demonstrated that the tenacity with which an animal will "work" in an experimental situation is a function not only of the intensity of the organic need that is being employed as the so-called "drive" but also of the size of the "reward" (i.e., the extent of drive reduction) that the animal expects to receive for its efforts. Fletcher (17), for example, has shown that with hunger held constant, chimpanzees will work reliably harder to pull in a weighted food box if they see the experimenter put a large piece of food into it than if they see him put in a small piece. In the former case, the animal's "incentive" is said to be stronger, which can only mean, since the strength of drive is constant and since the lure is seen only momentarily, that the difference in vigor of response in the two cases is occasioned solely by a corresponding difference in expectancy. As previously posited (45), expectancy or preparatory set is itself a form of discomfort, and if the sight of a large piece of food can be assumed to produce (as a conditioned reaction) a stronger expectancy, i.e., a greater readiness to eat, than the sight of a smaller piece of food, it is then understandable why "incentives" of varying size have differential motivational efficacy.

It may be noted in passing that by thus regarding both expectancy of "reward" (decreased drive) and expectancy of "punishment" (increased drive) as forms of discomfort (rather than as one being "pleasant" and the other "unpleasant"), it

is possible to account for the motivational value of each on the basis of a single, unitary principle. This is in keeping with an attempt that has been made elsewhere (43) to show that so-called "learning through reward" is not basically different from "learning through punishment". By eliminating this traditional distinction, a real advance can be made toward a simpler, more coherent and comprehensive theory of behavior.

IMPLICATIONS

By and large, psychological writers can be divided into three groups on the basis of their views concerning the learning process: (i) those who believe that all learning follows the principle of association through temporal contiguity (simple conditioning), (ii) those who believe that all learning occurs according to the law of effect, and (iii) those who believe that learning can come about through the operation of both principles. As originally formulated the law of effect had two sub-principles: (a) that stimulus-response connections are strengthened or "stamped in" by satisfying ("pleasant") consequences, and (b) that stimulus-response connections are weakened or "stamped out" by painful ("annoying") consequences. Recently there has been a tendency to abandon this dichotomous formulation and to assume instead that the law of effect operates only in a positive direction, that established habits disappear only as a result of their being overlaid by the acquisition of new habits. As pointed out previously (43), (45), this revision of the law of effect has considerably increased its force and attractiveness. There has been, however, one major source of objection to it as a comprehensive theory of learning. Students of human learning have repeatedly asked what "drive" is "satisfied", when, for example, a subject memorizes a series of nonsense syllables. And animal experimenters have asked where the element of "pleasure" or "gratification" is in the conditioning of a simple withdrawal response, where the conditioned stimulus, for example, is a tone and the unconditioned stimulus a momentary electric shock that cannot be avoided.

These have not been idle questions. For some time it has been clear that if the law of effect is to be seriously considered as the universal mechanism underlying all learning, the concept of "gratification", or "pleasure", must be extended beyond the notion of fulfillment of basic organic needs. As stressed in the introductory section, learning can obviously occur, particularly in human beings, when all such needs are apparently well taken care of. Eschewing such vague, unanalyzed concepts as "need for new experience", "wish for superiority", "desire for social approval", and so forth, the present writer believes that the extension of the source and scope of motivation required in this connection can be accomplished by simply adding to the organically specifiable needs, the notion of expectancy, i.e., a state of tension or discomfort involving anticipation of the recurrence of one or more of these needs. The evidence mobilized in the preceding sections of this paper gives empirical support for the assumption, scarcely debatable on common-sense grounds, that such a state of tension is high before the occurrence of a repeated noxious stimulus event (such as the momentary shock commonly employed in conditioning a simple defence reaction) and low immediately thereafter (see Fig. 3), thus providing appropriate conditions for the operation of the law of effect. It follows from this analysis that, other things equal, the greater the extent of the drop in expectancy-tension after the occurrence of a stimulus-response sequence, the greater the "reinforcing", or learning-inducing, value of this drop. Direct experimental confirmation of this inference has already been obtained and will be published shortly, thereby lending further strength to the underlying assumptions.²¹

Contending against the English "empiricists", who held that the human "mind" is composed of "associations" that are

²¹ Brown (9) has recently reported the interesting finding that in memorizing nonsense syllables, human subjects show maximal galvanic skin responses to those syllables that are learned first, i.e., those that occur at the beginning and at the end of a series. In view of the relationship between expectancy and the G. S. R. as noted above, this is an extremely suggestive observation. The discovery of Muenzinger (46) and others that "shock for right responses" in a discrimination experiment with rats may facilitate learning, also appears relevant in this connection.

acquired more or less passively, as a consequence of the impingement of stimuli from the external world, James (31) long ago took the position that learning is essentially an active process, for the occurrence of which "attention" is an indispensable prerequisite. In this stand James would certainly be heartily supported by most present-day educators. As one writer (50) says:

"To the extent that an individual is able to give attention is he able to bring more or less into play his powers of acquiring knowledge. . . . There is no doubt that the lack of the requisite amount of attention greatly decreases the efficiency of one's mind. The estimation of the composite thing known as intelligence is quite important; of importance too is the determination of the extent to which mental forces may be concentrated on the task at hand" (p. vii).

May (41) has recently commented upon the extent to which anxiety (anticipation of "punishment") is conventionally employed to motivate class-room learning. This mechanism probably operates in a number of ways not ordinarily recognized. When, for example, a teacher says (in however pleasant a voice), "Attention, boys and girls", there tends to be aroused on the part of the pupil an expectation that something is going to be demanded of him, that all will be well if he can meet this demand, but that if he cannot "something will happen". He may be somewhat vague as to what this "something" will be, but he knows that it will be a "loss" to him, loss of some accustomed privilege or of his own physical and emotional comfort (at least temporarily). Freud (20) has shown that anticipation of such a loss is the essence of anxiety; it is also the essence of what is here termed expectancy, of which anxiety is but a special, more accentuated form (45).

From principles now at hand, a deduction of a highly practical character can be made, namely, that in order for class-room learning to proceed efficiently, the arousal of anxiety (expectancy) must be followed as promptly as possible by its dissipation, after a "correct" reaction is made. A good teacher, in other words, knows how to turn the "heat" off as well as turn it on. But even such a teacher is likely to be relatively ineffectual (i) in the case of children whose performances fail (for whatever reason) to approximate the class standard and who, sensing this, remain

ill at ease and apprehensive and (ii) in the case of children whose level of anxiety is chronically so high, due to "neurotic" mechanisms, that it is virtually impossible to produce a significant reduction in it at appropriate points in the educational program. A more or less successful attempt has been made in some schools to deal with the first of these problems by the creation of "opportunity" classes (in which poor students can do "average" work) and to meet the second by referring children to appropriate agencies for psychotherapy.

These considerations apply with equal force to the training that children receive in the home which is commonly referred to as the socialization process. Most parents would impulsively deny that they train their children primarily by means of fear, insisting instead that they sway them through "love". Careful analysis shows, however, that the latter type of influence is no less dependent upon the arousal of apprehension than is control by the threat of corporal punishment. Among other writers, Anna Freud (19) has stressed this point of view. She says:

"In the earliest years, the child is under the domination of two powers, an inner one, due to the pressure of its own instincts, and an external one, due to the commands and prohibitions of parents. . . . Thus the power of the parents is the source of a twofold anxiety, which makes the child amenable to upbringing. First, there is the fear of being injured by the parents if their wishes are opposed. . . . Secondly, there is the fear of the loss of love of parents [with resulting deprivations]. Psychoanalytic pedagogy regards the threat of castration [physical punishment] and the threat of the loss of love, both of which are used to a greater or less extent by all parents, as the two chief factors which make possible the upbringing of the child" (p. 565).

Without an adequate appreciation on the part of parents of the nature of the forces they are employing in their rôle as educators, it is not surprising that the personality development of their children often proceeds along lines contrary to their avowed wishes and to the dictates of the culture. Nor is it surprising that in the so-called maladjusted adult the source of his difficulties is commonly traceable to anxieties that stem from childhood.

In order, therefore, to approach the problem of education, with its broad and vital social implications, in the soundest, safest manner, it is clearly essential that the conditions and consequence of the use of expectancy, or anxiety, as a motive for

learning be more thoroughly understood than it has been in the past. The present paper represents an attempt, at an elementary level, to further this sort of understanding.

Bibliography

1. ADRIAN, E. D., and MATTHEWS, B. H. C. The Berger rhythm: potential changes from the occipital lobes of man. *Brain*, 1934, **57**, 355-384.
2. ANDERSON, O. D., and LIDDELL, H. S. Observations on experimental neurosis in sheep. *Arch. Neurol. Psychiat., Chicago*, 1935, **34**, 330-354.
3. BAGCHI, B. K. The adaptation and variability of response of the human brain rhythm. *J. Psychol.*, 1937, **3**, 463-485.
4. BAKES, F. P. Effect of response to auditory stimulation on the latent time of blocking of the Berger rhythm. *J. exp. Psychol.*, 1939, **24**, 406-418.
5. BORING, E. G. The physical dimensions of consciousness. New York: The Century Co., 1933. Pp. 251.
6. BREITWIESER, J. V. Attention and movement in reaction time. *Arch. Psychol., New York*, 1911, **2**, 1-49.
7. BROGDEN, W. J. Unconditioned stimulus-substitution in the conditioning process. *Amer. J. Psychol.*, 1939, **52**, 46-55.
8. BROWN, J. S. A note on a temporal gradient of reinforcement. *J. exp. Psychol.*, 1939, **25**, 221-227.
9. BROWN, C. H. The relation of magnitude of galvanic skin responses and resistance levels to the rate of learning. *J. exp. Psychol.*, 1937, **20**, 262-278.
10. CALVIN, J. S. Decremental factors in conditioned-response learning. (Yale Ph.D. Dissertation, 1939.)
11. COLLINS, T. F. Arboreal life and the evolution of the human eye. New York: Lea and Febiger, 1922. Pp. 108.
12. COWLES, J. T., and NISSEN, H. W. Reward-expectancy in delayed responses of chimpanzees. *J. comp. Psychol.*, 1937, **24**, 345-358.
13. CRUIKSHANK, R. M. Human occipital brain potentials as affected by intensity-duration variables of visual stimulation. *J. exp. Psychol.*, 1937, **21**, 625-641.
14. DARROW, C. W. The equation of the galvanic skin reflex curve: I. The dynamics of reaction in relation to excitation background. *J. gen. Psychol.*, 1938, **16**, 285-309.
15. DURUP, G., and FESSARD, A. L'électrencéphalogramme de l'homme. Données quantitatives sur l'arrêt provoqué par des stimuli visuels et auditifs. *C. r. Soc. Biol. Paris*, 1936, **122**, 756-758.
16. ELLSON, D. G. A quantitative study of spontaneous recovery as a function of the interval following extinction. (Yale Ph.D. Dissertation, 1939.)
17. FLETCHER, F. M. Effects of quantitative variation of food-incentive on the performance of physical work of chimpanzees. (Yale Ph.D. Dissertation, 1939.)
18. FREEMAN, G. L. Postural tensions and the conflict situation. *Psychol. Rev.*, 1939, **46**, 226-240.
19. FREUD, A. Psychoanalysis of the child. In Murchison, C., *Handbook of Child Psychology*, 555-567. Worcester: Clark Univ. Press, 1931. Pp. 711.
20. FREUD, S. The problem of anxiety. New York: Norton, 1936. Pp. 165.

21. GREYER, W. F. Pseudo-conditioning without paired stimulation encountered in attempted backward conditioning. *J. comp. Psychol.*, 1938, **25**, 91-96.
22. HATHAWAY, S. R. An action potential study of neuromuscular relations. *J. exp. Psychol.*, 1935, **18**, 285-298.
23. HILGARD, E. R., and BIEL, W. C. Reflex sensitization and conditioning of eyelid responses at intervals near simultaneity. *J. gen. Psychol.*, 1937, **16**, 223-234.
24. HOVLAND, C. I. 'Inhibition of reinforcement' and phenomena of experimental extinction. *Proc. nat. Acad. Sci., Wash.*, 1936, **22**, 430-433.
25. HOWARD, H. Action potentials from the intact human brain in visual and auditory stimulation. (Unpublished Master's Thesis, Brown University, 1935.)
26. HULL, C. L. Learning: II. The factor of the conditioned reflex. In Murchison, C., *Handbook of General Experimental Psychology*. Worcester: Clark Univ. Press, 1934. Pp. 382-455.
27. HUMPHREYS, L. G. Acquisition and extinction of verbal expectations in a situation analogous to conditioning. *J. exp. Psychol.*, 1939, **25**, 294-301.
28. HUMPHREYS, L. G. The effect of random alternation of reinforcement on the acquisition and extinction of conditioned eyelid responses. *J. exp. Psychol.*, 1939, **25**, 141-158.
29. HUMPHREYS, L. G. Extinction of conditioned psycho-galvanic responses following two conditions of reinforcement (to appear).
30. HUMPHREYS, L. G., MILLER, J., and ELLSON, D. G. The effect of the inter-trial interval on the acquisition, extinction, and recovery of verbal expectations (to appear).
31. JAMES, W. The principles of psychology, Vol. I. New York: Holt, 1890. Pp. 689.
32. JASPER, H. H. Electrical signs of cortical activity. *Psychol. Bull.*, 1937, **34**, 411-481.
33. JASPER, H. H., CRUIKSHANK, R. M., and HOWARD, H. Action currents from the occipital region of the brain in man as affected by variables of attention and external stimulation. *Psychol. Bull.*, 1935, **32**, 565.
34. KNOTT, J. R. Some effects of 'mental set' on the electrophysiological processes of the human cerebral cortex. *J. exp. Psychol.*, 1939, **24**, 384-405.
35. LANDIS, C., and HUNT, W. A. The startle pattern. New York: Farrar & Rinehart, 1939. Pp. 168.
36. LANGE, N. Beiträge zur Theorie der sinnlichen Aufmerksamkeit und der activen Apperception. *Philos. Studien*, 1888, **4**, 390-422.
37. LINDNER, R. M. An experimental study of anticipation. *Amer. J. Psychol.*, 1938, **51**, 253-261.
38. LOOMIS, A. L., HARVEY, E. N., and HOBART, G. Electrical potentials of the human brain. *J. exp. Psychol.*, 1936, **19**, 249-279.
39. LURIA, A. R. The nature of human conflicts. New York: Liveright, 1932. Pp. 431.
40. MAY, M. A. Illustrations of stimulus-response principles in educational psychology (unpublished).
41. MILLER, J. The effect of facilitatory and inhibitory attitudes on eyelid conditioning. (Yale Ph.D. Dissertation, 1939.)
42. MOWRER, O. H., RAYMAN, N. N., BLISS, E. L. Preparatory set (expectancy)—an experimental demonstration of its 'central' locus. *J. exp. Psychol.* (in press).

43. MOWRER, O. H. Preparatory set (expectancy)—a determinant in motivation and learning. *Psychol. Rev.*, 1938, **45**, 62-91.
44. MOWRER, O. H. An experimental analogue of "regression", with incidental observations on "reaction-formation". *J. Abnorm. (soc.) Psychol.*, 1940, **35**, 56-87.
45. MOWRER, O. H. A stimulus-response analysis of anxiety and its role as a reinforcing agent. *Psychol. Rev.*, 1939, **46**, 553-565.
46. MUENZINGER, K. F. I. Electric shock for correct response in the visual discrimination habit. *J. comp. Psychol.*, 1934, **17**, 267-277.
47. MÜLLER, G. E., and SCHUMANN, F. Ueber die psychologischen Grundlagen der Vergleichung gehobener Gewichte. *Pflüg. Arch. ges. Physiol.*, 1889, **45**, 37-112.
48. PAVLOV, I. P. Conditioned reflexes. London: Oxford Univ. Press, 1927. Pp. 430.
49. RHEINBERGER, M. B., and JASPER, H. H. The electrical activity of the cerebral cortex in the unanesthetized cat. *Amer. J. Physiol.*, 1937, **119**, 186-196.
50. PHILIP, R. The measurement of attention. *Stud. Psychol. Psychiat., Cathol. Univ. Amer.*, 1928, **2**, 1-81.
51. RUSSELL, B. Philosophy. New York: Norton, 1927. Pp. 307.
52. SCHILDER, P. Conditioned reflexes. *Arch. Neurol. Psychiat., Chicago*, 1929, **22**, 425-443.
53. SCHLOSBERG, H. Conditioned responses in the white rat. *J. genet. Psychol.*, 1934, **45**, 303-335.
54. SMITH, G. E. The new vision—Bowman Lecture. *Trans. Ophth. Soc. Utd. Kgd.*, 1928, **48**, 64-85.
55. TRAVIS, L. E., and EGAN, J. P. Conditioning of the electrical response of the cortex. *J. exp. Psychol.*, 1938, **22**, 524-531.
56. TUTTLE, W. W. The effect of attention or mental activity on the patellar tendon reflex. *J. exp. Psychol.*, 1924, **7**, 401-419.
57. WHIPPLE, G. M. Manual of mental and physical tests. Baltimore: Warwick and York, 1924. Pp. 367.
58. WOODROW, H. The measurement of attention. *Psychol. Monogr.*, 1914, **17**, No. 76. Pp. 58.
59. WOODWORTH, R. S. Experimental psychology. New York: Holt, 1938. Pp. 889.
60. WUNDT, W. Grundzüge der physiologischen Psychologie. Leipzig: Engelmann, Vol. II, 2nd Edition, 1880. Pp. 472.
61. YACORZYNSKI, G. K., and GUTHRIE, E. R. A comparative study of involuntary and voluntary conditioned responses. *J. gen. Psychol.*, 1937, **16**, 235-257.